Earth rotation parameters from satellite techniques

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Overview

- Sub-daily Earth rotation:
  - GPS, GLONASS and SLR
  - Time-series (up to 1-hour resolution)

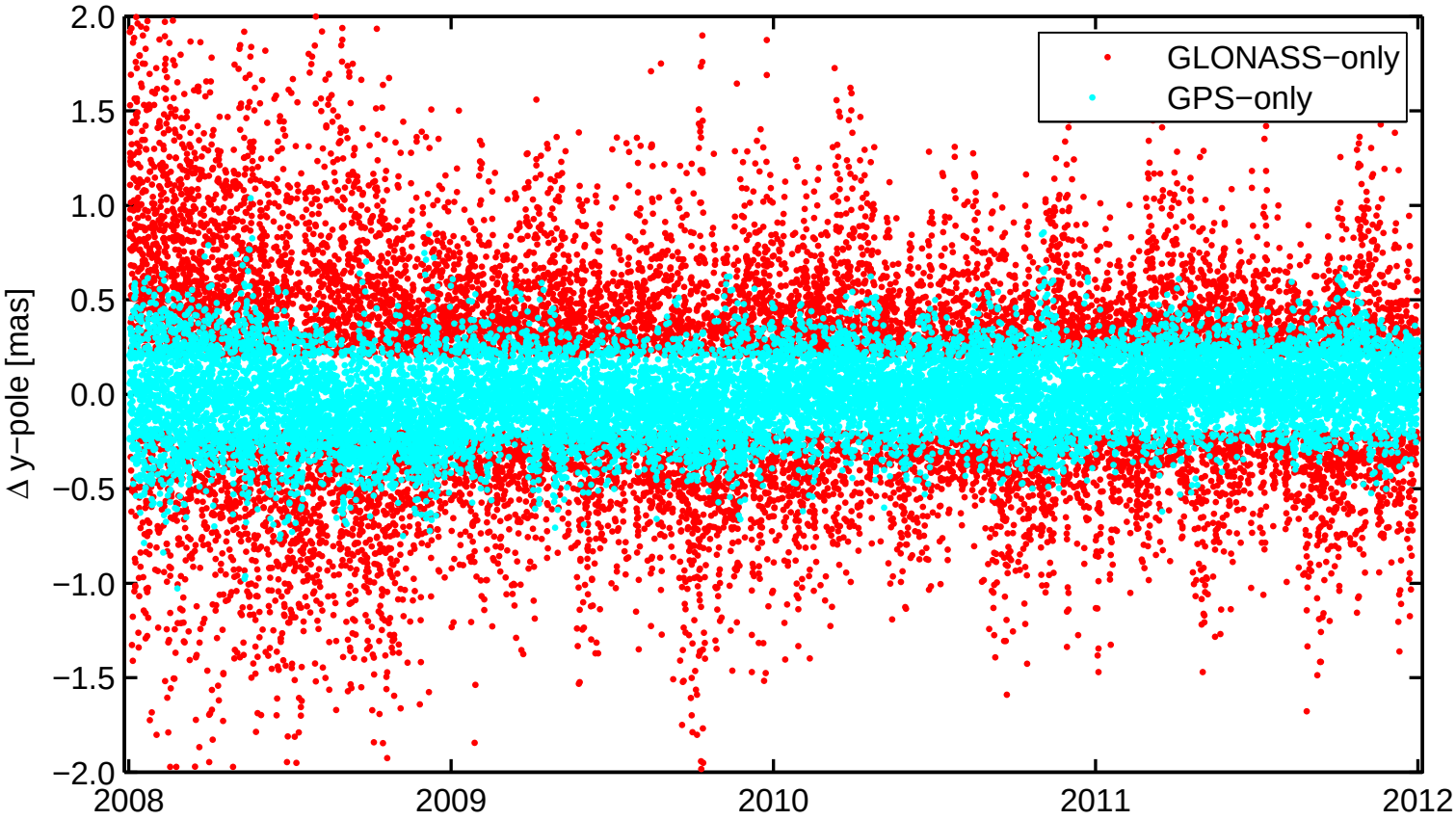
- Impact of gravity field variations on ERPs:
  - Estimation of low-degree gravity field coefficients together with ERPs
  - GNSS and SLR solutions

Sub-daily ERPs

Comparison of different satellite systems:

- GPS-only:
  - 2008 – 2011
  - Daily solutions
  - 1.5 hour temporal resolution
- GLONASS-only:
  - Settings / network identical to GPS-only solution
- LAGEOS-only:
  - 2001 – 2011
  - Weekly solutions
  - Testing different temporal resolutions (1 h, 2 h, 3 h)

Sub-daily ERPs: Time series PM



GLONASS: WRMS = 372.6 μas

GPS: WRMS = 162.2 μas

=> PM based on GLONASS is clearly noisier than PM based on GPS

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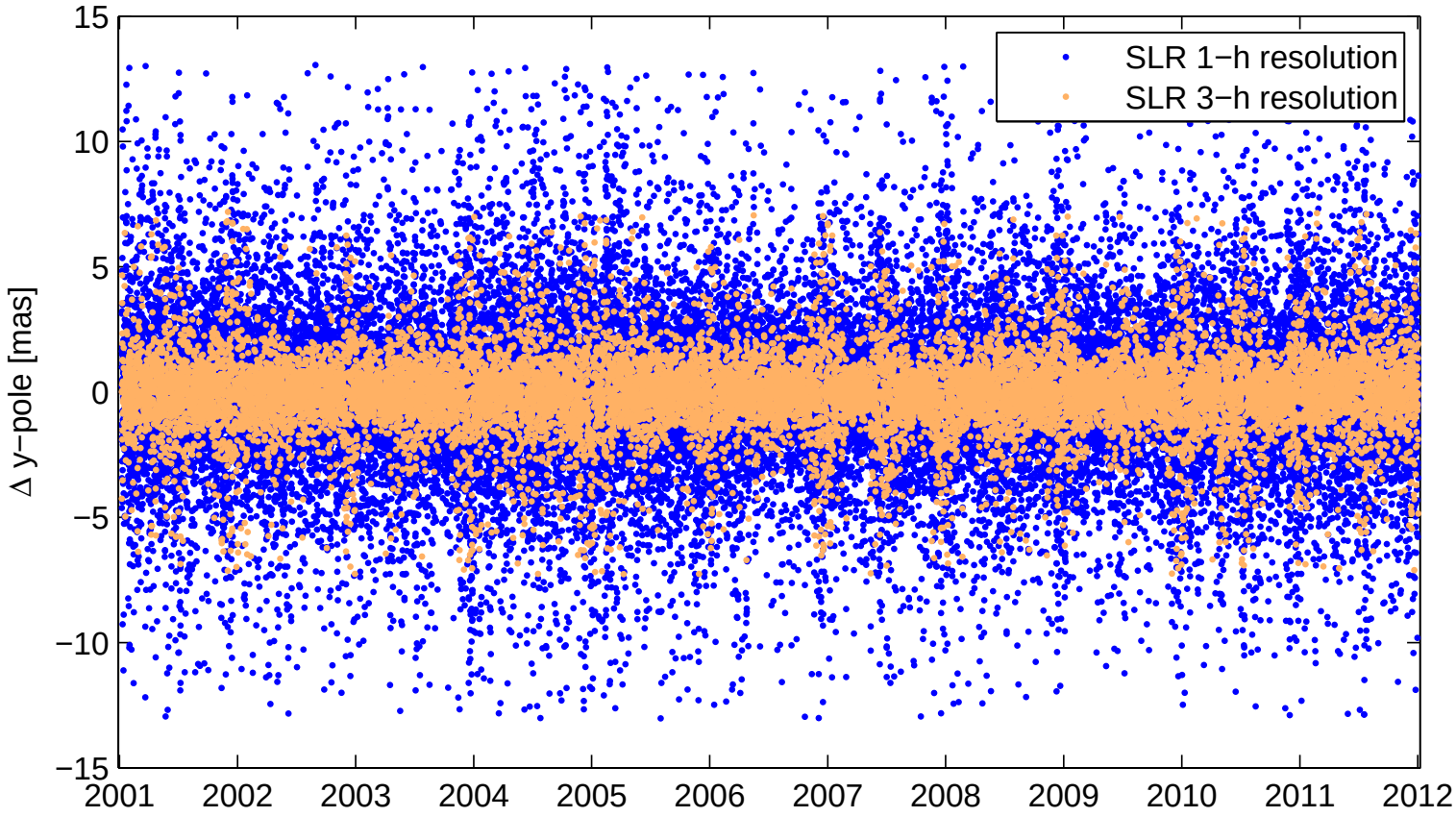
Sub-daily ERPs: Time series PM



SLR 1-h: WRMS = 1648.6 μas

SLR 2-h: WRMS = 1213.1 μas (not shown)

SLR 3-h: WRMS = 1050.7 μas

=> 1-hour resolution might be too high for SLR

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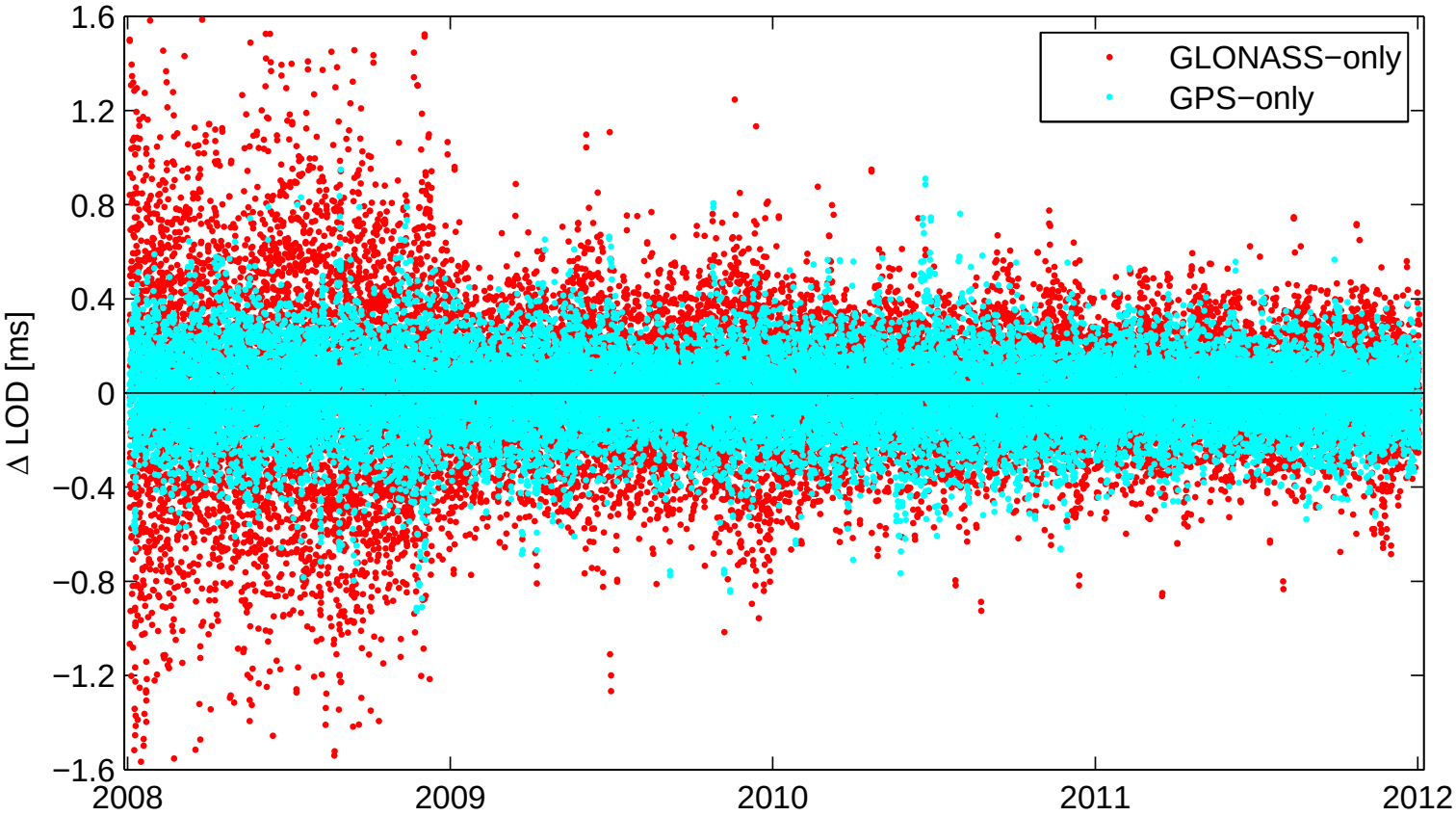
Sub-daily ERPs: Time series LOD



GLONASS: WRMS = 229.5 μs

GPS: WRMS = 161.9 μs

=> GLONASS has similar quality as GPS if full satellite constellation is available

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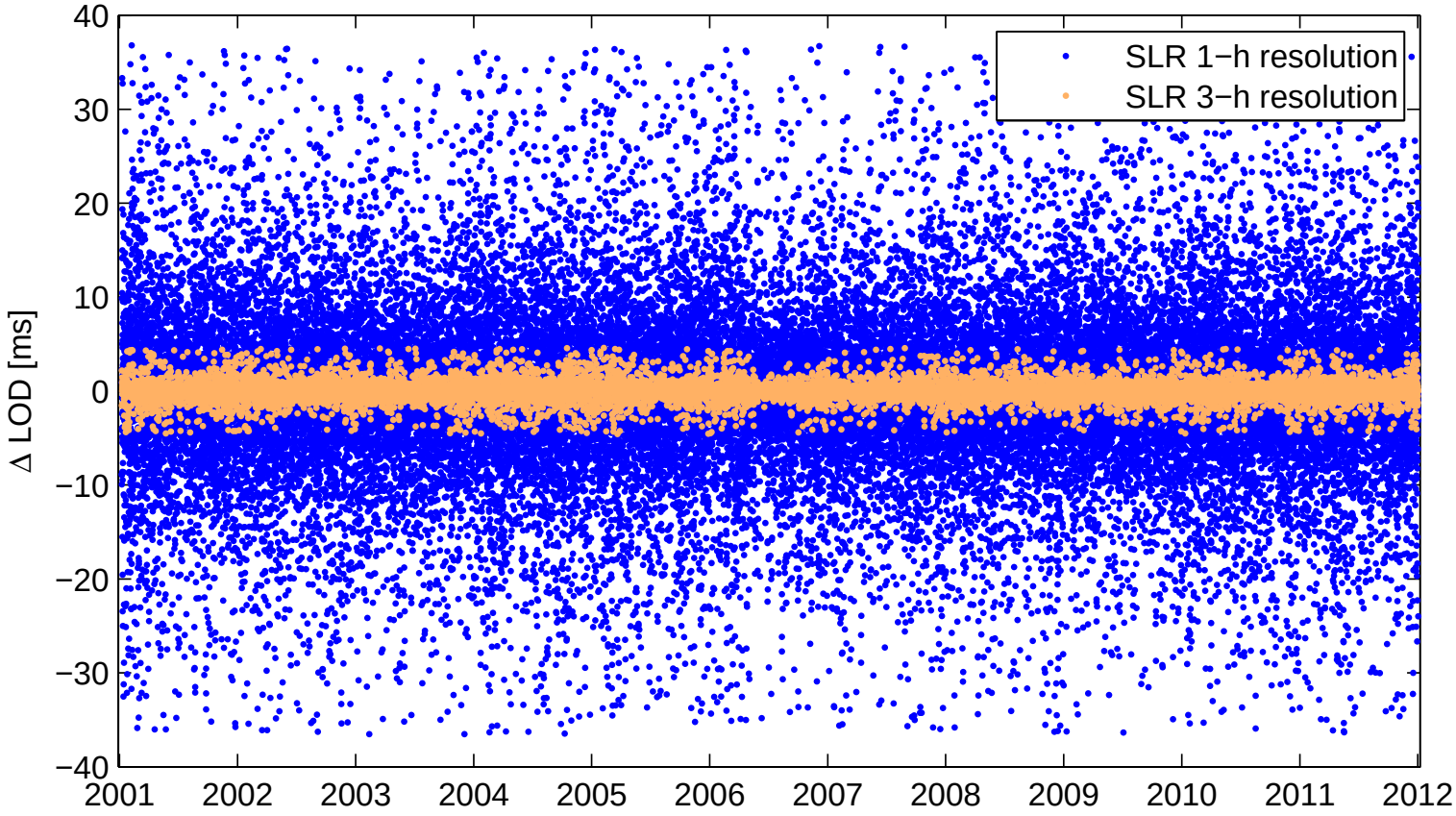
Sub-daily ERPs: Time series LOD



SLR 1-h: WRMS = 4380.0 μs

SLR 2-h: WRMS = 1171.3 μs

SLR 3-h: WRMS = 552.1 μs

=> The temporal resolution has a bigger impact on LOD than on PM

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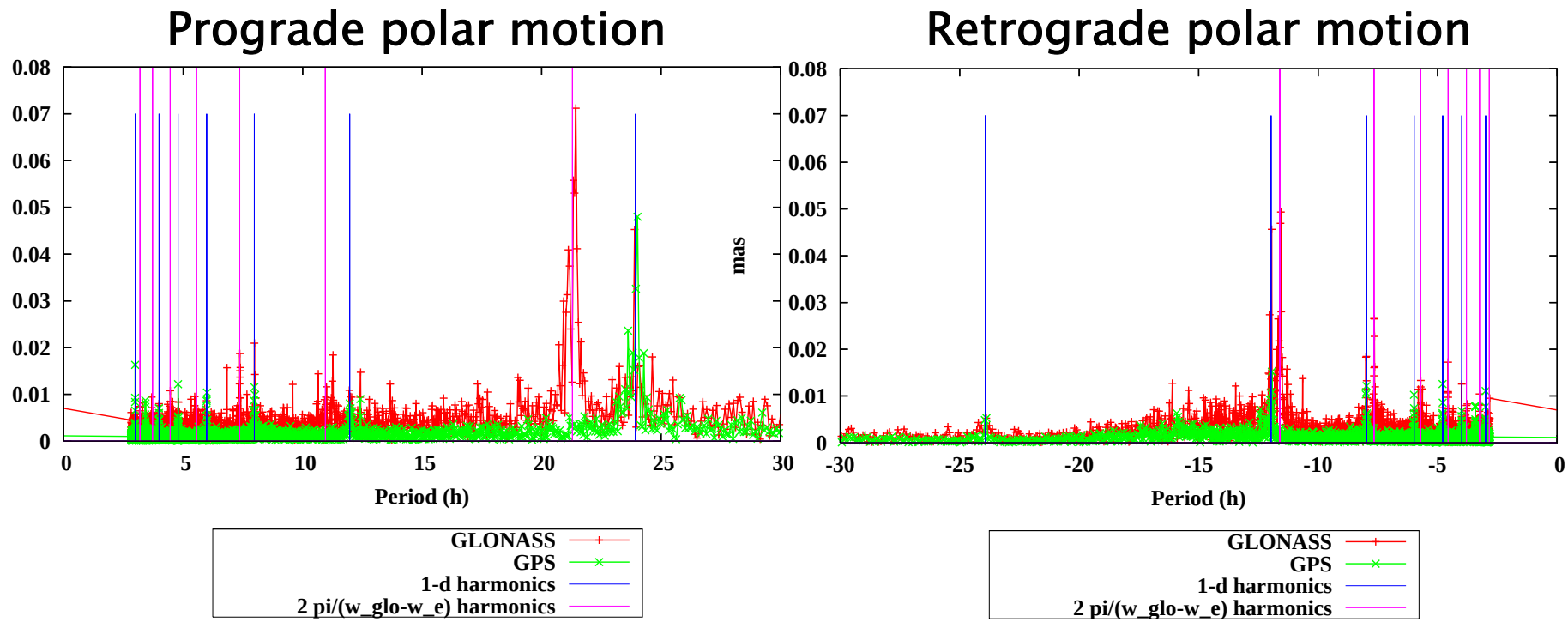
Sub-daily ERPs: Spectra of PM time-series



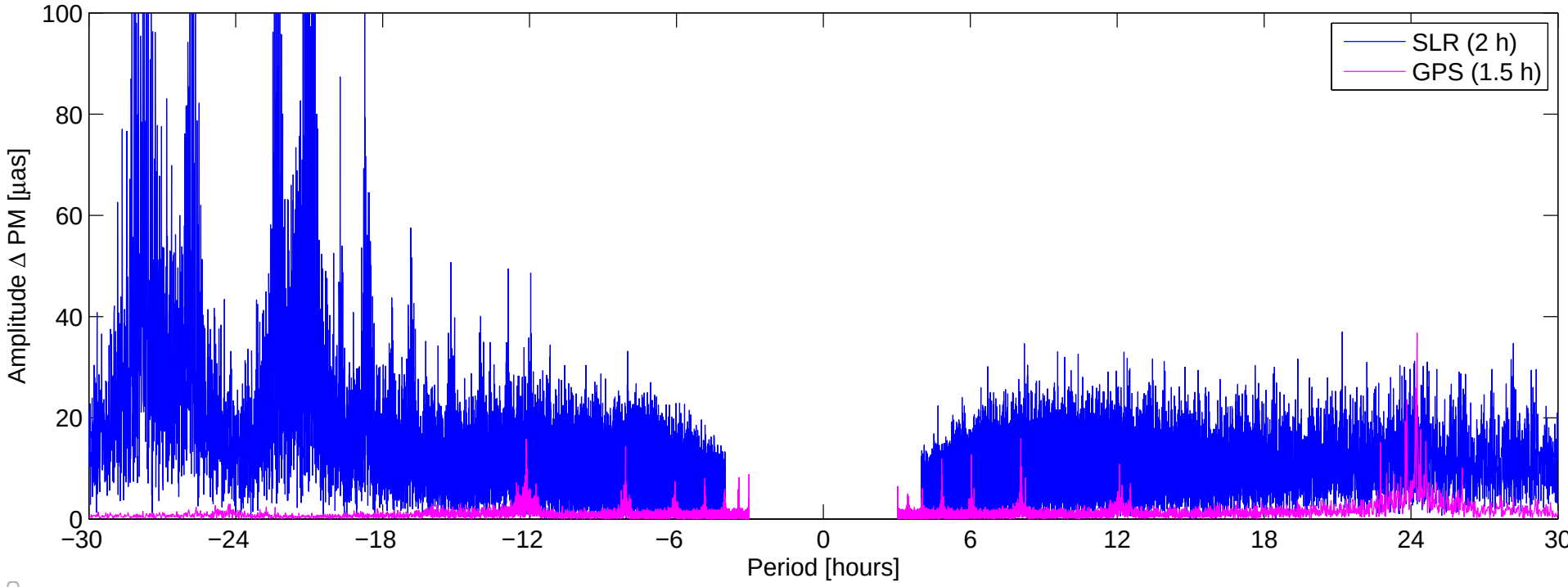
- GPS: many orbital artefacts

  = harmonics of a diurnal period

- GLONASS: many orbital artefacts

  = harmonics of linear combination of the Earth's and the satellites' revolution periods

Sub-daily ERPs: Spectra of PM time-series



SLR-LAGEOS:

- Many artefacts in retrograde PM: linear combinations of Earth's and satellites' revolution periods (3.75 h)
- Prograde PM does not have artefacts (but much larger noise level than GNSS)

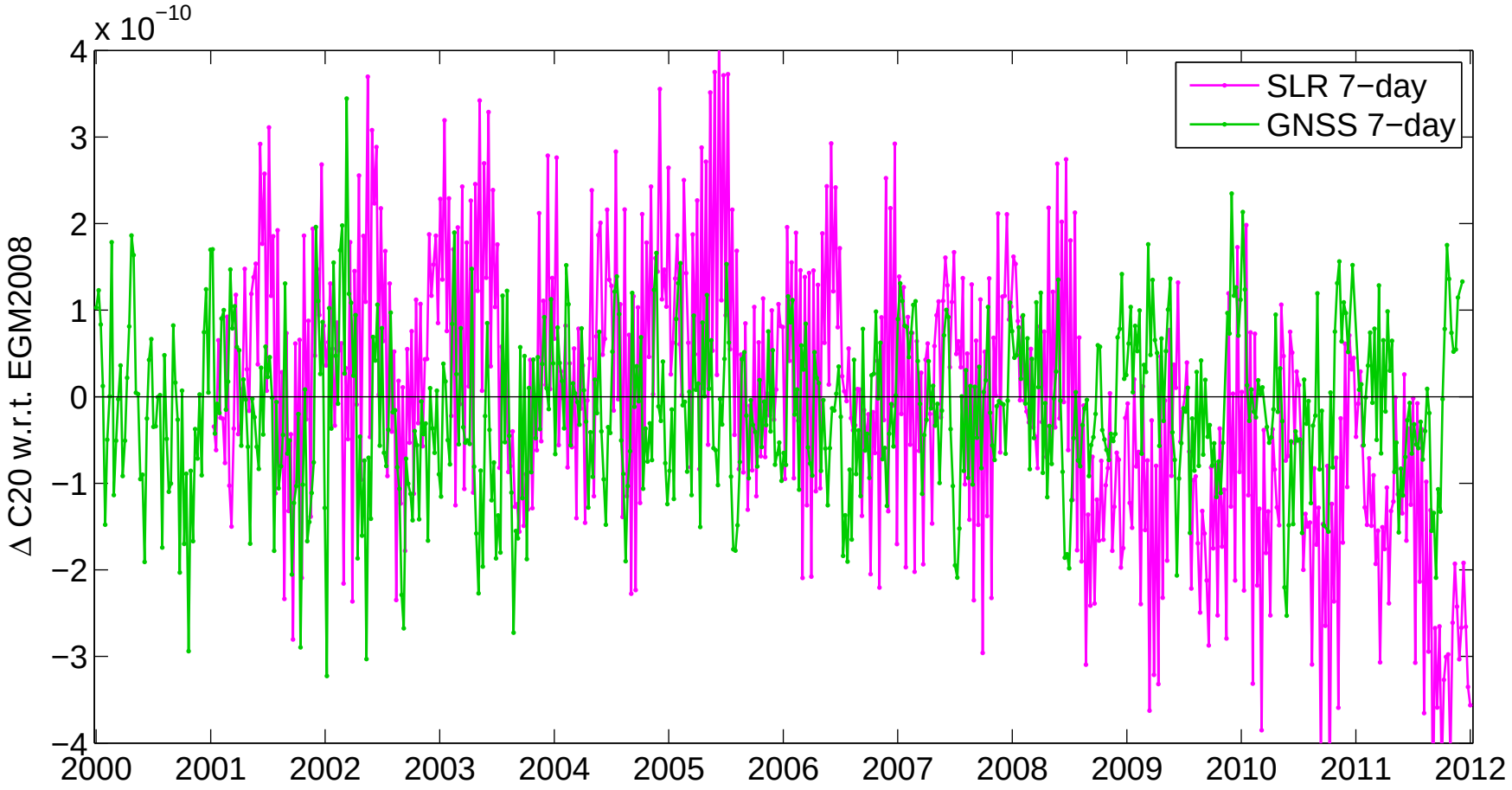
Impact of low-degree gravity

- **2 types of solution series** are computed:
  - **No** gravity field coefficients estimated
    (= «Standard» solution)
  - **C20 estimated**

- GNSS: weekly solutions, 2000 – 2011

- SLR: weekly solutions, 2001 – 2011

Impact of low-degree gravity: C20



Variations are not negligible

Formal errors: ~1.e-12

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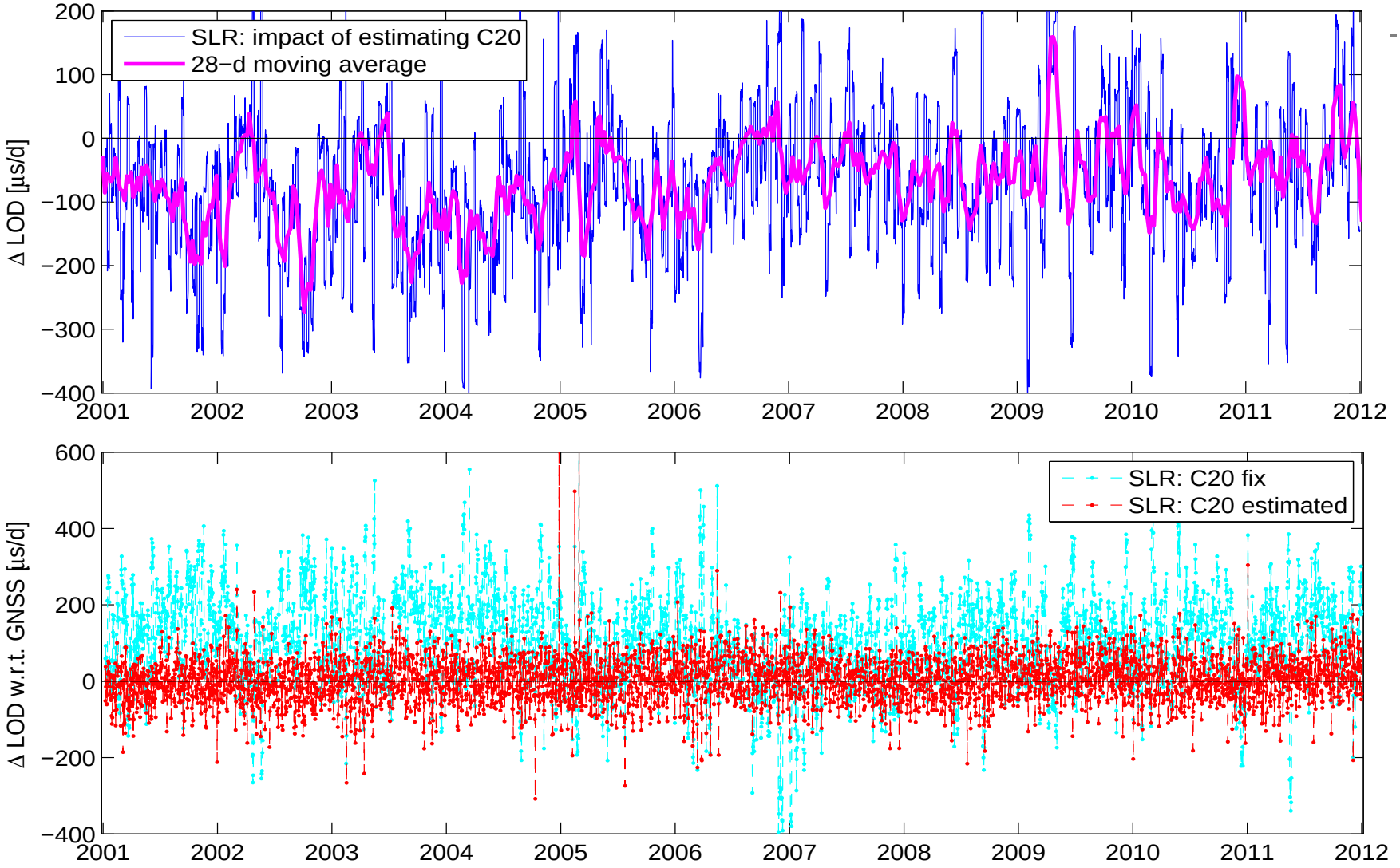
Impact of low-degree gravity: SLR



LOD is shifted if C20 is not estimated: ~ 74 µs

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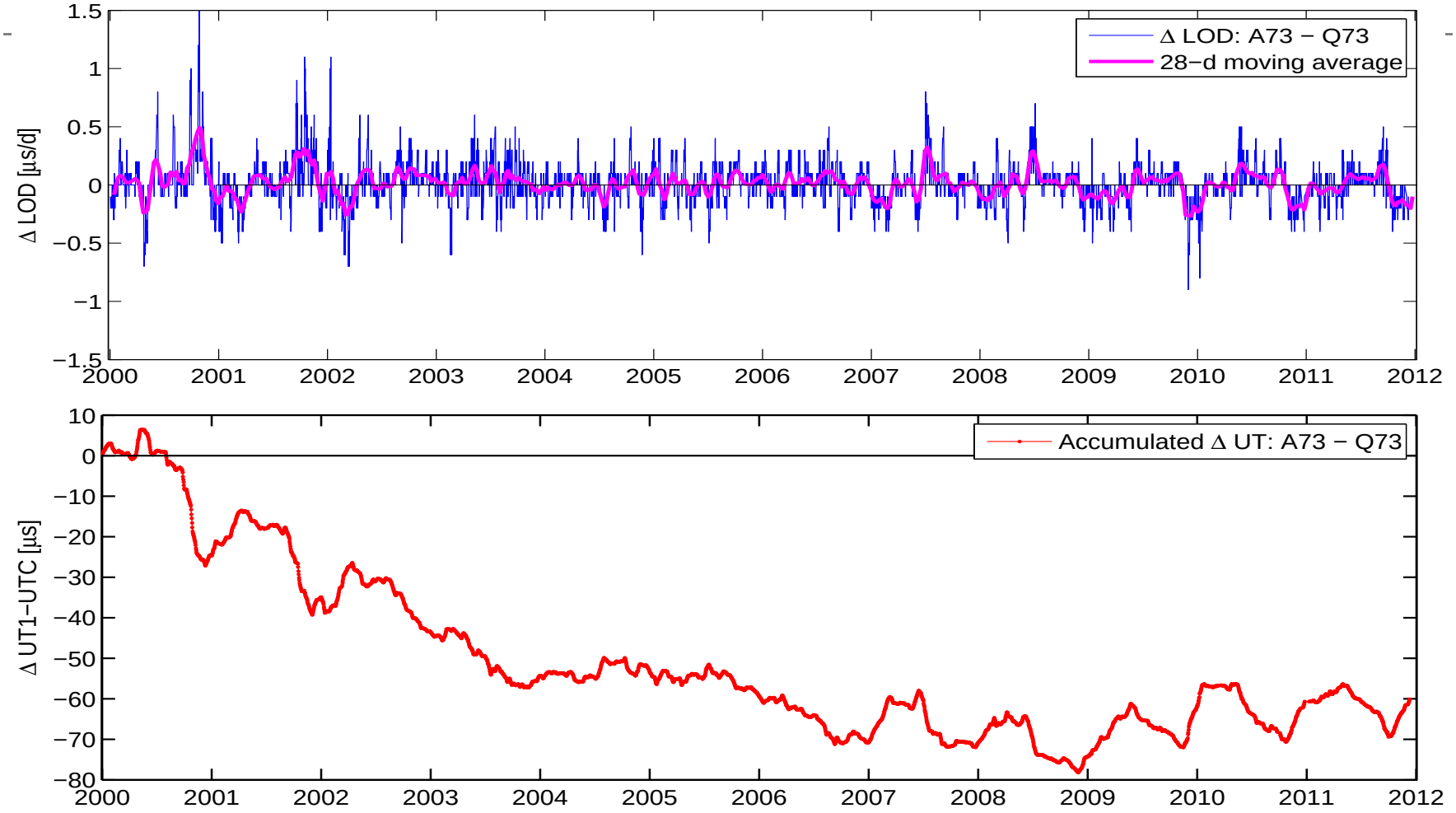
Impact of low-degree gravity: GNSS



Impact of estimating C20 on UT1-UTC / LOD seems to be small

BUT: Accumulated effect is not negligible

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Conclusions

- **Sub-daily ERPs:**
  - Orbit-related artefacts in all satellite techniques
  - SLR capability is surprisingly good (considering the small amount of data)
  - 1-h resolution is too high for SLR, but 2-h resolution seems feasible

- **Impact of low-degree coefficients of the Earth's gravity field:**
  - Impact of C20 was studied
  - SLR: LOD is shifted by ~74 μs
  - GNSS: Accumulated effect reaches ~70 μs after few years
  - Consequence: C20 should be estimated together with ERPs